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Proximate Composition and Amino Acid Profile of *Glossogobius matanensis*, an Endemic Fish from Lake Towuti: Implications for Domestication

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ABSTRACT

This study aimed to analyze the proximate and amino acid profile of the endemic fish *Glossogobius matanensis* from Lake Towuti as a basis for the development of domestication and the utilization of a local protein source. Fish samples were collected from three different stations, namely Timbala Cape, Lengkobutanga Cape, and Bakara Cape, and then analyzed in the laboratory using standard AOAC methods. The proximate analysis results show a relatively high protein content (37.64–37.66%), a dominant moisture content (76.82–77.96%), low fat (1.80–1.98%), stable ash (3.41–3.45%), and consistent carbohydrates (1.83%). These findings confirm the characteristics of tropical freshwater fish, which are high in protein and low in fat, making them potential sources of nutritious food. The amino acid profile analysis reveals a complete composition of both essential and non-essential amino acids. The dominant essential amino acids are leucine (14,504.22 mg/kg), lysine (12,126.08 mg/kg), and valine (7,983.83 mg/kg), while the non-essential ones are dominated by glutamate (28,793.88 mg/kg) and aspartate (20,310.02 mg/kg). The high content of Branched-Chain Amino Acids (BCAA**)** indicates a crucial role in muscle growth, energy metabolism, and nutritional quality. The high glutamate and aspartate content also contributes to the umami flavor and the sensory quality of the fish meat. Overall, the research results confirm that *G. matanensis* possesses significant potential as a high-quality protein source and a candidate for the development of functional food. These data can serve as the scientific basis for sustainable conservation, domestication, and aquaculture programs for endemic Sulawesi fish to support local food security.

INTRODUCTION

Lake Towuti is one of the largest tectonic lakes in eastern Sulawesi and is part of the Malili lake system, which is characterized by unique ecological features and a high level of fish endemism **(Herder *et al.*, 2012)**. This ecosystem is recognized as a global

aquatic biodiversity hotspot due to the presence of many fish species that are not found in other waters. The existence of endemic fish is not only ecologically important but also holds potential value for the development of sustainable local food resources **(Prianto *et al.*, 2016)**.

One of the most prominent endemic fish species in Lake Towuti is *Glossogobius matanensis*. This species, belonging to the family Gobiidae, is a benthic fish that plays an essential role in the food chain and in maintaining the balance of the aquatic ecosystem. Furthermore, fish from the genus *Glossogobius* are known to have relatively high protein content, making them a potential source of nutritious food **(Ghosh *et al.*, 2021)**. However, scientific information regarding the nutritional composition, particularly the proximate and amino acid profiles of *Glossogobius matanensis* as an endemic fish species, remains very limited.

Proximate analysis (protein, fat, moisture, ash, and carbohydrate) provides a fundamental overview of fish quality as a food resource **(AOAC, 2005)**. The protein and fat contents of fish are generally the main indicators for evaluating their potential for consumption and the development of fish-based processed products **(Aakre *et al.*, 2020)**. On the other hand, amino acid profile analysis is essential to assess fish protein quality, since the adequacy of essential amino acids determines nutritional value and health benefits **(Elaigwu, 2019)**.

Previous studies conducted on *Glossogobius* species in Lake Towuti have mainly focused on growth and mortality, genetic diversity, biological aspects, reproductive aspects, population biology, and the presence of species such as *G. flavipinnis* and *G. intermedius* **(Nursyahran *et al.*, 2024)**. However, studies specifically investigating the biochemical characteristics of *G. matanensis*, such as proximate composition and amino acid profile, have not been conducted.

The novelty of this study lies in the fact that the proximate composition and amino acid profile of *G. matanensis* have never been previously reported. Such information provides insights into the nutritional value of this fish based on variations in nutrient composition influenced by environmental factors, body size, developmental stage, and ecological roles within the Lake Towuti ecosystem.

Comprehensive data on the proximate composition and amino acid profile of *Glossogobius matanensis* are expected to support the optimal utilization of this endemic species from Lake Towuti. Moreover, this information is crucial as a scientific basis to strengthen conservation, domestication, and sustainable aquaculture development programs for endemic fishes in Sulawesi

MATERIALS AND METHODS

The sampling locations of *G. matanensis* were determined based on selected stations in the Lake Towuti area, namely Tanjung Timbala Cape, Lengkobutanga Cape, and Bakara cape (Fig. 1).

Fish sampling was carried out monthly for four months at each research station in Lake Towuti. The *G. matanensis* specimens obtained from each station were separated, and each fish was labeled with a code indicating its location of capture. The fish samples were stored in an icebox and transported to the laboratory for proximate, fatty acid, and amino acid analyses.

The physiological profile analysis of *G. matanensis* consisted of: (a) analysis of protein, fat, and carbohydrate contents through proximate composition of the fish body; (b) amino acid analysis, which included essential amino acids (lysine, leucine, threonine, valine, isoleucine, phenylalanine, methionine, histidine, and tyrosine) and non-essential amino acids (glutamic acid, glycine, aspartic acid, alanine, arginine, proline, serine, tryptophan, and cysteine). (d) The achievement indicator was a comprehensive description of the proximate and amino acid profiles of *Glossogobius* sp.

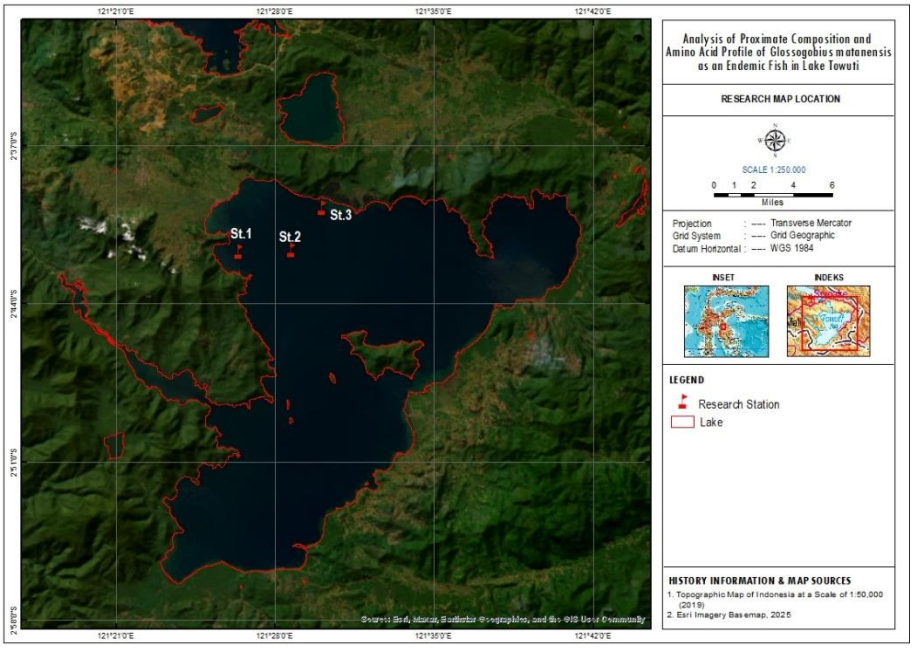

Fig. 1. Map of research stations

RESULTS

a. Proximate composition of *G. matanensis*

Table 1. Results of proximate analysis of *G. matanensis* in Lake Towuti

Sample	Nutrient Content (%)	Station 1	Station 2	Station 3
G. matanensis	Protein	37.66	37.64	37.66
	Moisture	77.96	77.92	76.82
	Fat	1.80	1.80	1.98

Sample	Nutrient Content (%)	Station 1	Station 2	Station 3
	Ash	3.41	3.45	3.44
	Carbohydrate	1.83	1.83	1.83

The results of the proximate analysis of the fish *Glossogobius matanensis* obtained from three different stations in Lake Towuti show a relatively stable variation in nutritional content across locations (Table 1). The protein content of *G. matanensis* from Station 1 (Timbala Cape), Station 2 (Lengkobutanga Cape), and Station 3 (Bakara Cape) were 37.66, 37.64, and 37.66%, respectively. This indicates that this fish has a high and consistent protein level across all sampling locations.

The moisture content in each station also shows high and similar values: 77.96% at Station 1, 77.92% at Station 2, and slightly lower at 76.82% at Station 3. The fat content is relatively low, with values of 1.80% at Station 1 and 2, while Station 3 is slightly higher at 1.98%, reflecting the general characteristic of tropical freshwater fish which are typically low in fat.

The ash content, which is an indication of body minerals, is also relatively uniform, ranging from 3.41 to 3.45% between stations. Meanwhile, the carbohydrate content remained stable at 1.83% across all three sampling locations.

Overall, the proximate composition of *Glossogobius matanensis* exhibits characteristics of a fish with a high protein value, low fat content, and high moisture content, which are typical traits of tropical freshwater fish. This profile confirms the nutritional potential of this fish as a high-quality protein source that can support the development of sustainable aquaculture and food utilization in Lake Towuti.

b. Amino acid profile of *G. matanensis*

Table 2. Essential amino acid profile of *G. matanensis* in Lake Towuti

Essential amino acid parameter (mg/kg)	*G. matanensis*
L-Phenylalanine	7098.97
L-Isoleucine	7845.42
L-Valine	7983.83
L-Lysine	12126.08
L-Leucine	14504.22
L-Threonine	7139.85
L-Tyrosine	7499.24
L-Histidine	4453.60

The analysis of the essential amino acid profile showed that *G. matanensis* contains a complete set of essential amino acids, including phenylalanine, isoleucine, valine, lysine, leucine, threonine, tyrosine, and histidine. However, there were quantitative differences between the two species. Phenylalanine in *G. matanensis* was 7098.97mg/ kg.

While isoleucine was 7845.42mg/ kg; this amino acid is important for energy metabolism and hemoglobin synthesis. Valine was 7983.83mg/ kg. Lysine was 12,126.08mg/ kg; lysine is crucial for calcium absorption, collagen formation, and antibody production. Leucine was 14,504.22mg/ kg; leucine is a Branched-Chain Amino Acid (BCAA) essential for muscle protein synthesis and tissue repair. Threonine was 7139.85mg/ kg; threonine contributes to elastin and collagen formation and helps maintain protein balance in the body. Tyrosine was 7499.24mg/ kg; tyrosine is vital for neurotransmitter production (dopamine, adrenaline). Histidine was 4453.60mg/ kg; histidine is essential in fish for growth and histamine production, which plays a role in immune responses. The high leucine content in *G. matanensis* indicates that this species has strong potential as a source of high-quality protein, particularly for supporting muscle growth and energy metabolism. Lysine, which is often the limiting amino acid in both animal and plant protein sources, was also present in substantial amounts. Overall, both species possess good protein quality and are worth considering as functional food sources.

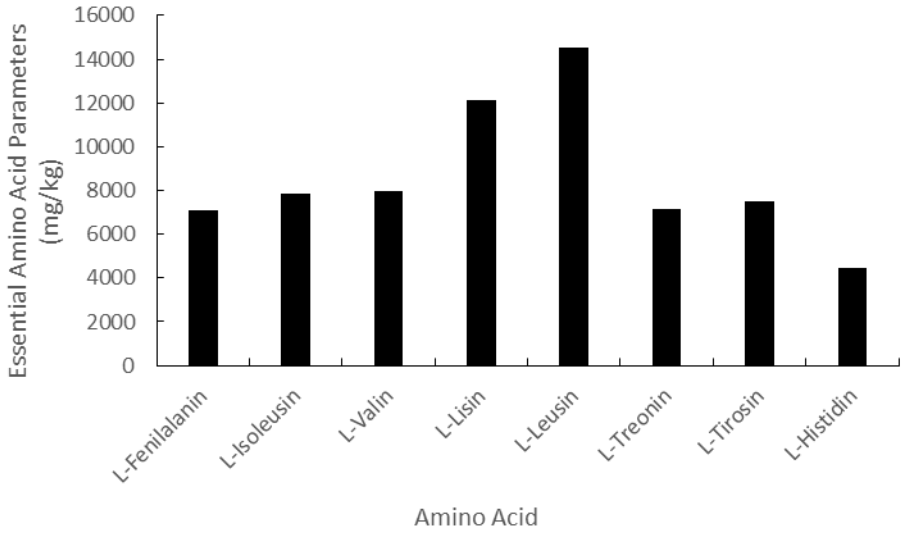

Fig. 2. Essential amino acid profile of *G. matanensis*

c. Non-essential amino acid profile of *G. matanensis*

Table 3. Non-essential amino acid profile of *G. matanensis* in Lake Towuti

Parameter (Non-Essential Amino Acids, mg/kg)	*G. matanensis*
L-Serine	7095.23
L-Glutamic acid	28793.88
L-Alanine	10665.02
L-Arginine	10257.88

Parameter (Non-Essential Amino Acids, mg/kg)	***G. matanensis***
Glycine	8503.55
L-Aspartic acid	20310.02
L-Proline	5731.05

Table (3) presents the results of the analysis of non-essential amino acid content in *Glossogobius matanensis*. This profile is characterized by the dominance of two amino acids that are highly important, both for fish metabolism and for the sensory quality of the flesh. The two amino acids with the highest concentrations are: L-Glutamic Acid: with a concentration of 28,793.88mg/ kg and L-Aspartic Acid recorded at 20,310.02mg/ kg. Aspartic acid is one of the dominant amino acids that supports energy metabolism through the citric acid cycle and acts as a precursor for gluconeogenesis. The high levels of glutamate and aspartate indicate a greater metabolic capacity in *G. matanensis*.

Other non-essential amino acids were also found in significant amounts and play important functional roles: L-Alanine: 10,665.02mg/ kg. Alanine supports energy metabolism via the glucose-alanine cycle. L-Arginine: 10,257.88mg/ kg. Arginine plays a role in the urea cycle, nitric oxide synthesis, and immune enhancement. Glycine was 8,503.55mg/ kg. Glycine is a major component of collagen, influencing meat elasticity and texture. L-Serine was 7,095.23mg/ kg. Serine is essential for protein synthesis and cell membrane phospholipid formation. L-Proline was 5,731.05mg/ kg. Proline is also a component of collagen and elastin, contributing to meat texture and tissue elasticity. Overall, this non-essential amino acid profile highlights the potential of *G. matanensis* as a source of high-quality protein.

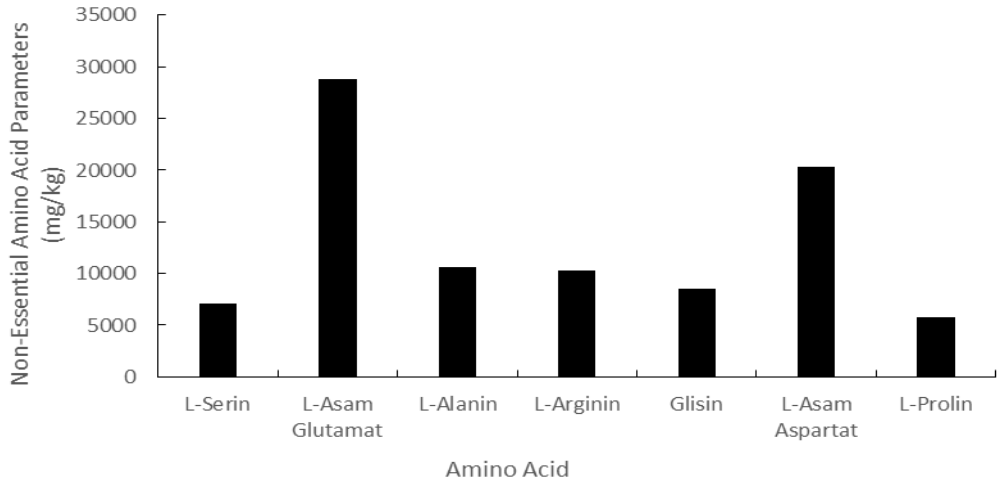

Fig. 2. Non-essential amino acid profile

DISCUSSION

Proximate composition (Protein, lipid, moisture, ash, carbohydrate)

The results of the analysis revealed that *G. matanensis* contains protein (37.6%), which is a primary indicator of fish nutritional quality as it functions in growth, tissue repair, and supports reproductive processes **(FAO, 2020)**. Variations in protein content may be attributed to the availability of natural feed, physiological factors, and aquatic environmental conditions. A study on snakehead fish (*Channa striata*) also reported that body size and habitat strongly influence fish protein composition **(Matondang, 2022)**.

The low lipid content (<2%) of *G. matanensis* is consistent with the characteristics of tropical freshwater fish, categorized as low-fat or lean fish **(Sabba *et al.*, 2023)**. Although present in small amounts, lipids are crucial as an energy source and provide essential fatty acids. The high moisture content (>76%) aligns with the profile of other tropical freshwater species **(Adeyeye, 2009)**. However, high water content reduces shelf life, thereby requiring appropriate post-harvest processing. The ash content (3.44%) reflects the mineral composition of the fish, which is influenced by environmental factors such as water quality and the availability of dissolved minerals **(M *et al.*, 2014)**.

Overall, the proximate composition demonstrates that *G. matanensis* possesses superior nutritional quality, particularly in terms of protein content, highlighting its potential as a valuable source of food protein.

The proximate analysis also shows that protein is the dominant component supporting growth. High crude protein directly contributes to the formation of muscle tissue, enzymes, and hormones. Somatic growth in fish is largely driven by protein accumulation, thus a high body protein content reflects greater growth potential **(Froese, 2006; Turnipseed, 2024)**. Although crude protein provides a quantitative measure, protein quality is determined by the presence of essential amino acids. Amino acids such as lysine, methionine, threonine, and leucine play critical roles in tissue synthesis and are considered limiting amino acids, which can restrict protein utilization if insufficient **(Breves *et al.*, 2016)**. In fish, adequate levels of essential amino acids are directly associated with growth efficiency **(Rachmawati *et al.*, 2023)**. Crude protein thus represents the total available amino acids.

Essential amino acids

The essential amino acid profile analysis revealed that *G. matanensis* has a complete composition, though with quantitative variation. The species exhibited high levels of leucine (14,504.22mg/ kg), valine (7,983.83mg/ kg), and isoleucine (7,845.42mg/ kg). Leucine, one of the Branched-Chain Amino Acids (BCAAs), plays a vital role in muscle protein synthesis, tissue repair, and energy metabolism **(Mann *et al.*, 2021)**. The high BCAA content in *G. matanensis* indicates strong nutritional potential to support muscle growth and metabolic health.

The lysine content (12,126.08 mg/kg) is particularly important, as lysine is a limited amino acid in many protein sources. It is essential for calcium absorption, collagen formation, and immune enhancement **(Holeˇ, 2025)**.

Non-essential amino acids

Analysis of non-essential amino acids revealed that glutamic acid (28,793.88 mg/kg) dominated in *G. matanensis*. Beyond its role in protein synthesis, glutamate serves as a neurotransmitter precursor and provides the umami flavor, enhancing the organoleptic quality of fish meat **(Sano, 2009)**. This finding is consistent with other freshwater species where glutamate and aspartate dominate the non-essential amino acid profile **(Adeyeye, 2009)**.

Aspartic acid (20,310.02 mg/kg) was also present in high amounts, playing a crucial role in energy metabolism through the citric acid cycle and acting as a precursor for gluconeogenesis **(Francis *et al.*, 2019)**. The high levels of glutamate and aspartate in *G. matanensis* indicate greater metabolic capacity, supporting both growth and sensory quality.

Other amino acids such as alanine, serine, arginine, glycine, and proline were also found at relatively high concentrations. Arginine plays a role in the urea cycle, nitric oxide synthesis, and immune function **(Ding *et al.*, 2023)**. Glycine and proline are key components of collagen, contributing to muscle structure and tissue elasticity. Their higher levels in *G. matanensis* suggest superior meat texture and physiological value.

Ecological influence and nutritional potential

The variations in proximate and amino acid composition demonstrate the influence of ecological factors, body size, and habitat conditions in Lake Towuti on the biochemical profile of fish **(Herder *et al.*, 2012)**. *G. matanensis* shows distinct advantages in protein content, essential amino acids (leucine, valine, isoleucine), and non-essential amino acids (glutamate, aspartate, proline), which collectively support growth, energy metabolism, and sensory quality.

From a nutritional and food perspective, *G. matanensis* holds significant potential as a high-quality protein source. Its complete amino acid profile and glutamate dominance not only make it a valuable protein source but also a candidate for the development of functional foods. The domestication and aquaculture of this endemic species could strengthen local food security while conserving aquatic biodiversity in the Malili Lakes system.

Essential amino acids determine protein quality and utilization, while lipids (proximate) act as the main energy source, enabling protein to be allocated toward growth rather than energy expenditure. Minerals (ash content) support amino acid metabolism and bone formation. Thus, proximate analysis provides a quantitative overview, whereas amino acid analysis offers a qualitative assessment of the growth potential of *Glossogobius matanensis* in Lake Towuti, which is characterized as oligotrophic–mesotrophic with limited nutrient availability. These conditions result in relatively slow but stable growth.

Proximate and amino acid analyses therefore provide the basis for formulating species-specific diets to meet the nutritional requirements of *G. matanensis* for domestication **(Haffner *et al.*, 2001; Herder *et al.*, 2012; Hadiaty, 2018)**

CONCLUSION

This study demonstrates that *Glossogobius matanensis*, an endemic species from Lake Towuti, possesses superior nutritional quality characterized by high protein content (~37.6%), low lipid levels (<2%), and a complete profile of essential and non-essential amino acids. The dominance of leucine, lysine, and valine among essential amino acids indicates strong potential to support muscle growth, tissue repair, and immune function, while the high concentrations of glutamate and aspartate among non-essential amino acids highlight enhanced metabolic capacity and sensory quality through umami characteristics. These biochemical traits not only confirm the value of *G. matanensis* as a source of high-quality protein but also position it as a promising candidate for functional food development. Moreover, its nutritional profile provides a scientific basis for domestication and aquaculture programs, contributing to sustainable utilization of endemic biodiversity and strengthening local food security in the Malili lakes ecosystem.

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